Single Transverse-Spin Asymmetry in $p^{\uparrow} p \to \pi X$ and $ep^{\uparrow} \to \pi X$

Y. Koike
Dept. of Physics, Niigata University, Japan

Our interest in the single transverse spin asymmetry for the pion production in *pp* and *ep* collisions resides in the fact that it probes particular quark-gluon correlation in the hadrons (higher twist effect) which is not included in the twist-2 parton distributions. QCD analysis for the asymmetry is crucial for the ongoing RHIC-SPIN, HERMES and COMPASS experiments.

In this contribution, we will present an analysis for the asymmetry in the framework of the collinear factorization [1-2]. According to the generalized QCD factorization theorem, the polarized cross section for $p^{\uparrow} p \to \pi X$ consists of three kinds of twist-3 cross sections,

$$(A) \quad G_a(x_1, x_2) \otimes q_b(x') \otimes \hat{q}_{c\to\pi}(z) \otimes \hat{\sigma}^1_{ab\to c^1} \tag{1}$$

$$(B) \quad \delta q_a(x) \otimes E_b(x'_1, x'_2) \otimes \hat{q}_{c\to\pi}(z) \otimes \hat{\sigma}^2_{ab\to c^1} \tag{2}$$

$$(C) \quad \delta q_a(x) \otimes q_b(x') \otimes \hat{E}_{c\to\pi}(z_1, z_2) \otimes \hat{\sigma}^3_{ab\to c^1} \tag{3}$$

and the one for $ep^{\uparrow} > \pi X$ likewise receives two contributions,

$$(A') \quad G_a(x_1, x_2) \otimes \hat{q}_{a\to\pi}(z) \otimes \hat{\sigma}, \tag{4}$$

$$(C'') \quad \delta q_a(x) \otimes \hat{E}_{a\to\pi}(z_1, z_2) \otimes \hat{\sigma}'. \tag{5}$$

Here the functions with two variables (momentum fractions) $G_a(x_1, x_2), E_a(x_1, x_2), \hat{E}_{c\to\pi}(z_1, z_2)$ are twist-3 quantities: G_a and E_a are respectively, the transversely polarized distribution and the unpolarized distribution functions in the nucleon. $\hat{E}_{c\to\pi}$ is the unpolarized fragmentation function for the pion. *a*, *b* and *c* stand for the parton's species. Other functions are twist-2; $q_b(x)$ the unpolarized distribution, $\delta q_a(x)$ the transversity distribution, $\hat{q}_{c\to\pi}$ the unpolarized fragmentation function. $\hat{\sigma}^1_{ab\to c}$ etc. represents the partonic cross section which yields large transverse momentum of the pion.

The analyses of (A) and (B) contributions have been provided in [1] and [2], respectively. Here we extend the analysis to the (C) term (for a preliminary study, see [3] and the $ep^{\uparrow}$ case so that we can have more thorough understanding on the hadron structure and the reaction mechanism.

References

[1] J. Qin and G. Sterman, Phys. Rev. **D59** (1999) 014004.
[2] Y. Kanazawn and Y. Koike, Phys. Lett. **B478** (2000) 121; **B490** (2000) 99.
[3] Y. Koike, hep-ph/0106260, Proceedings of DIS2001. (Bologna, Italy, April 2001.)